slower motion and to their generally entering the shadow more obliquely; their inclinations and nodes were less accurately known, while it was well known that the motions of the outer satellites differed in a very irregular manner from Cassini's tables by amounts much larger than that dealt with in the case of the first satellite. The deviation in question was neither a function of the anomaly of Jupiter nor of that of the earth, nor of the configuration of the satellites, but solely of the distance from the earth. Writing to Colbert shortly afterwards, Huygens calls the discovery a most important one, in the confirmation of which the Royal Observatory would be worthily employed, and he adds that he was all the more pleased, as he had himself already, by means of this hypothesis, demonstrated the laws of the double refraction in Iceland spar. To Roemer he wrote that Cassini's objection did not trouble him much, as long as there were not better ephemerides of the outer satellites available. He doubted that observations of the surface-markings of Jupiter would be of any use in this inquiry, as they could not be accurate enough; but this Roemer did not acknowledge, since the time of passage of a spot across the central meridian could be fixed within two minutes. In a subsequent letter and in a communication to the Academy (which does not seem to have been printed before), Roemer proudly gives observations of a spot of September and December 1677, the comparison of which with an assumed value of the period of rotation seemed to exhibit the phenomenon beautifully. Of much greater interest is a remark made by Roemer in a letter dated December 30, 1677, in which he points out that the motion of the earth must affect the apparent direction of the path of light! In Cartesian language, he expresses this by saying that the circular motion of the terrestrial vortex must produce a curvature of the path, and he ingeniously suggests that the amount of this deflection might be determined by selecting two stars in the zodiac, nearly opposite each other, and observing their angular distance apart, first when one was at its heliacal rising, and again four or five months later when the other approached its heliacal setting. The difference would be four times the amount of the deflection, or, as we should say, four times the constant of aberration. It is very remarkable that Picard, Roemer's teacher and friend, should have discovered the changes in the place of the pole-star due to aberration (and also those due to nutation, though not the laws which regulate either—see his "Voyage d'Uranibourg," article viii.), while Roemer logically concluded from his discovery of the velocity of light that there ought to be aberration of light. But it was reserved for Bradley to publish both the laws and the theory of aberration. These facts become still more curious when we reflect that, but for the unfortunate destruction by fire of almost all Roemer's observations—which had been made with instruments constructed on novel principles not adopted elsewhere till much later, the foundation of modern astronomy might have been built on them and not on Bradley's observations. It was indeed unfortunate that Roemer published so very little about his scientific labours, and it is therefore particularly interesting to get a slight insight into them through his correspondence with Huygens.

Among other matters dealt with in this volume we may mention the controversy on the theory of the centre of oscillation between Huygens and Abbé de Catelan, a man whose aim in life seems to have been to object to every new mathematical publication and to exhibit his inability to grasp any new theory. In Vol. i. of Huygens' "Opera varia," the papers written by the two opponents, as well as by Jacques Bernouilli, who took Huygens' part, have already been printed side by side; but it is interesting to see from the correspondence that Catelan's attack was slyly inserted in the Amsterdam reprint of the *Journal des Scavans*, although it had not appeared in the original Paris edition.

The volume contains as frontispiece a plate reproducing a fine medallion of Huygens from 1679, and another showing a medal apparently struck in his honour in the same year. It is announced that his unpublished works are to appear in the volumes following immediately after those devoted to his correspondence.

J. L. E. DREYER.

## METAPHYSICS OF BIOLOGY.

*The Living Organism: an Introduction to the Problems of Biology.* By Alfred Earl, M.A. Pp. xiii + 271. (London: Macmillan and Co., Ltd., 1898.)

THE observer of the more recent phases of biological thought will not need to be told that during the last few years a reaction has been setting in, both in England and abroad, against any so-called mechanical theories of the origin and development of living things, and against any hypothesis which seeks in the facts of chemistry and physics for an ultimate explanation of the phenomena of life; and those who have had the opportunity of a more intimate acquaintance with this new philosophical development will know that the "neo-vitalist" adopts, as the basis of his scientific beliefs, an ontology which states that it is not true that the hierarchy of the natural sciences presents us with a material universe of which the separate parts studied by the several sciences can all be ultimately expressed in terms of one of them, biology in fact being a special case of chemistry, this of physics and so on; but that on the contrary every science deals, not with a part, but with the whole of the material universe, all the facts of which come under its survey, and as a particular manner of looking at which it is to be regarded. On this view, therefore, it is as useless ever to expect a physical explanation of the chemical atom as it is futile to hope that organic metabolism may after all turn out to be merely a specially complex chemical reaction: each science has what is, for itself, an ultimate fact, in terms of which it seeks to express the whole of nature, but which has nothing in common with the ultimate fact of any other science whatever. This ultimate fact is, for the vitalistic biologist, the living organism, and when pressed for an account of how the inanimate world is included in his science, he replies by a reference to the environment, which, we are told, is to be regarded as being made by and for the organism itself.

Now it may be that the ontology which includes, with Kant, all phenomena in but a single category is obsolete,

as these philosophers suggest, and that we must rather, with Hegel, look upon the universe from several points of view, though even Hegel, if we are not mistaken, would have made the various categories develop out of one another; but whether that be so or not, and however impossible it is at present to point to any scientifically complete demonstration of the correctness of the opposite hypothesis, it is necessary to inquire very carefully into the positive basis on which this revived vitalism, of which the present volume is an exposition, rests.

Starting with sundry somewhat loosely connected remarks on the nature of knowledge in general, and the method of biology in particular, the author, after giving a brief account of the functions of assimilation and reproduction in the living organism, touches, in a chapter on the relation of that organism to its surroundings, the keynote of his whole system. Since, we are told, the human organism is a knowing subject, the organism in general is to be regarded as not only object but also as subject; and hence all mechanical, or physical, or chemical explanations of organic function are and must ever be inadequate, because they take no account of that inexplicable residuum, the "spontaneous choice" or "selection," the "subordination to a purpose" which an organism displays in every function it performs, and most obviously of all in sensation, the act which puts it in immediate communication with its environment.

Now such a view as this seems to us to be pervaded by a most vicious anthropomorphism, due to an unfortunate confusion between the organism, or its nervous system, to which those parts of the phenomenal world outside it are related during the act of knowledge, on the one hand, and on the other the metaphysical *ego* or subject of knowledge. For knowledge is most certainly not, as the author seems to imagine (for he tells us that knowledge is part of the subject-matter of biological science) a relation between the organism and its environment, both of which are phenomenal, that is to say are events occurring in space and time, but a relation between phenomena and a timeless and spaceless noumenon, with which metaphysics alone is concerned, but with which science has nothing to do at all.

The endeavour to locate in the organism, regarded as matter for scientific inquiry, a "subjective" residuum is apt to remind one of the now discredited search for that metaphysical phantom, the "thing-in-itself," and it is incumbent upon biology, advancing along rigidly deterministic lines, to resist any attempt to transfer that "freedom of the will" which psychology cannot allow for the human organism, under the name of "spontaneous selection," to the purely objective phenomena exhibited in organic function.

There are, indeed, no grounds either in theory or in fact for regarding the organism as anything else but the transitory product of certain causes which it is the aim of the biologist to discover. When Mr. Earl speaks of constant form under an ever-changing material, he momentarily forgets the dominant fact of the evolution of form; and to whatever causes we assign this evolution, its existence is beyond a doubt; and when he speaks of the impossibility of applying quantitative conceptions to organic phenomena, he either ignores or is ignorant of certain recent work in this direction, in which, indeed, alone lies a hope for the progress of biology as a science.

Serious though the misconceptions seem to us to be which mar this essay, apart from certain minor details of arrangement to which exception might possibly be taken, and the mistake of discussing epistemological problems in a book apparently intended for beginners, we may at least hope that it will serve to convince those who may still be in doubt of the futility of attempting to apply to the living organism, which, like the subject-matter of any other science, should be studied from a strictly ætiological point of view, teleological conceptions which have not even a place in human psychology. Not that it is therefore to be supposed that when the sciences have said all they have to say our knowledge of the universe is at an end: the last word must always remain with metaphysics, in which those ideas of "freedom" and the "final cause" which science cannot accept may find their true proportions; for metaphysics looks upon the universe not merely as a continuous time-process, but as a whole, time and space being only the forms under which phenomena appear to a transcendental subject, in which the ultimate interpretation of them is to be sought, but which it is as fatal for metaphysics as it is for science to confound with the living organism.

## OUR BOOK SHELF.

*An Account of the Deep-Sea Ophiuroidea collected by the Royal Indian Marine Survey Ship "Investigator."* By R. Koehler. (Calcutta: 1899.)

THIS monograph, published by order of the Trustees of the Indian Museum, is well worthy its predecessors, now famous, and adds one more to the brilliant results of the *Investigator*, memorably associated with the names of Dr. A. Alcock, its editor, now superintendent of the Indian Museum, and his indefatigable co-workers in the Zoology of the Indian Seas. It is chiefly devoted to the description of forty species of Ophiurids which are new, the majority of the larger number obtained during the cruises of the ship having been already reported upon by Prof. Koehler in the *Annales des Sciences Naturelles*, as explained in the text. The new forms are of the genera *Ophiacantha* (7 species), *Amphiura* (5 sp.), *Ophioglypha* (4 sp.), *Ophiomusium*, *Ophiactis*, *Ophiochiton*, *Ophiomitra*, and *Gorgonocephalus*, each 2 sp., and thirteen other genera each 1. Interest chiefly centres in a new genus, *Ophiotypa*, obtained in the Gulf of Bengal at 1997 fathoms. *O. simplex* is the name by which the author would have it known, its special structural peculiarity being the great size of the primary plates of the disc, the aboral region of which is beset by an enormous pentagonal centro-dorsal and five equally large radials, separated by small but regular inter-radials. Interbrachial plates are present on the ventral face. Radial shields are absent, and the author, regarding this character and the small number of plates present in the disc of the adult as primitive, proceeds to a comparison with the young stages of *Amphiura*, as described by Ludwig and Fewkes, which would seem to justify the conclusion that *Ophiotypa*, as regards its skeleton, may be a persistently embryonic form.

The monograph is elaborately illustrated by fourteen exquisite plates, photo-etched from the author's drawings at the Survey of India Offices in Calcutta, and on perusal of its contents the mind reverts to the interesting series of Astrophiurids, whose "primary larval plates" and